(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 305 113 B1**

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **13.10.93** (51) Int. Cl.[5]: **B23P 15/04**, F01D 5/28

(21) Application number: **88307666.3**

(22) Date of filing: **18.08.88**

(54) Rotating or moving metal components and methods of manufacturing such components.

(30) Priority: **27.08.87 GB 8720248**

(43) Date of publication of application:
01.03.89 Bulletin 89/09

(45) Publication of the grant of the patent:
13.10.93 Bulletin 93/41

(84) Designated Contracting States:
DE FR GB IT

(56) References cited:
EP-A- 0 034 847
EP-A- 0 151 103
DE-A- 3 401 742
GB-A- 1 149 386
GB-A- 2 198 667

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Description

This invention relates to a method of manufacturing turbomachinery blades.

Certain kinds of gas turbine engine employ titanium alloy blades and discs in the compressor stage of the engine. The tip of each blade is designed to run in close proximity to a casing or an ablative lining on the casing. During certain aspects of engine operation, contact is possible and in some cases inevitable between the tip of the blades and the casing or its lining. In extreme conditions incidents of this type could result in the presence of titanium or titanium alloy dust being emitted from the titanium alloy blade tip. Such titanium alloy dust emitted from the tip of a blade in a compressor could in theory result in ignition of titanium dust and the ignition and propagation of fire in the titanium blades themselves.

It has been proposed in EP-A-0151103 to manufacture an article for transmitting forces, especially torques, via one or more teeth, cams, receptors or the like, constructed of at least two different materials.

In this disclosure, a tubular cylinder of one metallic material may surround an inner core of another metallic material, to which the material of the first outer tubular cylinder is bonded. Discs may then be cut from the resulting product to be used as blanks for cogs or the like.

Such a disc with a case of titanium alloy material might be considered for use as an attachment by one of its plane faces to a turbomachinery blade stem. The blade tip would however then need to be machined into its necessary aerodynamic shape, thereby removing most of the material of the outer circumference which might be made of an alloy whose dust was unlikely to be ignited in the engine. This however would not solve the problem mentioned above, since both the very end surface of the blade would be a titanium alloy, as would significant portions of the blade tip adjacent the very end. The risk of producing titanium dust by contact with the oblative alloys of the engine casing would thereby remain.

It is an object of the present invention to provide a method of manufacturing a turbomachinery blade which overcomes the disadvantages of such an arrangement.

According to one aspect of the invention a method of manufacturing an article comprising the steps of creating a composite component having a surface layer of material different from the body of the component by bonding said surface layer to said body, and parting said component at a plurality of locations to provide sections, characterised in that the article is a turbomachinery blade and the composite component has a plane surface layer, said parting taking place such that the sections extend perpendicular to said plane, and in that each parted section is subsequently attached to a blade stem by welding only the body portion of said section to said blade stem to form said blade.

The body of the component is typically a titanium alloy. The metal component section manufactured in accordance with the invention may subsequently be attached to the blade stem by welding the body of the component to the blade stem. The blade stem would be of a similar titanium alloy as that of the component body. Typically, the stem would be in its fully heat-treated condition. The attachment could be carried out for example by electron-beam welding or friction welding, and the complete blade would then need to be finish ground or machined to exact shape. The surface layer may be bonded to the titanium alloy or other metal by explosive bonding, diffusion bonding or friction welding or other bonding technique, all of which techniques are known per se, and which if applied in appropriately controlled conditions avoid the formation of significant quantities of intermetallic compounds beyond the boundary with the titanium alloy or other metal. Alternatively, the bonding may be carried out by mechanical working of the component eg by extrusion or rolling so as to extend the component in a direction parallel to the plane of the surface layer of material. Once again the working conditions, in particular the extent of heating up of the component, would need to be controlled to prevent the formation of large quantities of intermetallic compounds within the body of the titanium alloy or other metal.

There may be an interlayer present between the surface layer and the body of the component. Such interlayer will be selected such that it tends to resist diffusion of intermetallics from the surface layer of material into the body of the titanium alloy or other metal.

Either or both facing surfaces of the surface layer material and the body may be grooved or similarly machined prior to bonding. If both surfaces are grooved it is preferable that the grooves on one surface substantially intermesh with the grooves on the opposite surface. The interlayer is then placed between the grooved portions and bonding forces the interlayer to adopt a corrugated configuration.

Where the body is a titanium alloy, the surface layer of material is typically nickel or a nickel alloy or one or more of the following elements or their alloys; chromium, cobalt, copper, iron, hafnium, molybdenum, niobium or tantalum.

Where the body is a titanium alloy the interlayer is typically hafnium, molybdenum, niobium or tantalum or a compound of one or more of these materials with other elements. The interlayer may

comprise a plurality of layers of such materials eg there might be a tantalum alloy layer adjacent the titanium alloy and an iron alloy layer adjacent a nickel alloy tip.

The titanium alloy, the interlayer (if present) and the layer of material may initially be assembled within an external tube or sleeve. Such sleeve may comprise titanium or a titanium alloy or it could comprise copper with a steel interlayer between the copper tube or sleeve and its contents. Such outer tube or sleeve would typically be removed by etching or some similar process prior to the forging or the electro-chemical machining of the parted sections.

It should be stressed that the assembly and mechanical working of the composite material must avoid the possibility of any substantial diffusion from the layer of material into the titanium or titanium alloy, either during heating or heat treatment of the composite material during its processing, or during subsequent service of the component section. The thickness and composition of the intermetallic layer is designed with this consideration in mind.

The titanium alloy may typically be an alloy such as IMI 829 or IMI 834 or titanium 6242 which is in itself designed for application in the high pressure and therefore high temperature region of the compressor.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

FIGURE 1 is a schematic side elevation of a component part way through the process of manufacture,

FIGURE 2 is a schematic isometric view illustrating an alternative component part way through the process of manufacture,

FIGURE 3 is a schematic isometric view of a gas turbine blade made according to the invention, and

FIGURE 4 is a schematic view shoving one method of bonding a surface layer to the body of a component.

In Figure 1, a body 10 of titanium alloy has a surface layer 11 of nickel alloy bonded to it by explosive welding techniques. The composite is parted by known means along lines 12 to provide a plurality of similar semi-finished components or component sections. No interlayer is illustrated in Figure 1, but this is an alternative feature of the process, and would be positioned between surface layer 11 and the body 10.

Figure 2 illustrates part of the process for the manufacture of a tip section of a blade and the component 22 shown in dashed line is suitable to be subsequently welded onto the stem of such a blade. A single section 24, parted as shown in Figure 1, comprises a surface layer 21 of nickel alloy bonded to a body 20 of titanium alloy.

The finished turbine blade shown in Figure 3 has a stem portion 30 of titanium alloy to which a tip section component 31 has been attached by electron-beam welding along weld line 32. The tip section component 31 results from the finish machining or grinding of a component such as 22 from Figure 2. The very tip of the blade is composed of nickel alloy as distinct from the remainder of the blade which is of titanium alloy.

A specific bonding technique between a surface layer 41 and a body 40 is shown in Figure 4. In this example both facing surfaces 43 and 44 of the respective surface layer 41 and the body 40 are grooved such that they would interlock. Interposed between 43 and 44 is an interlayer 42, which when 40 and 41 are forced together eg by diffusion bonding, takes up a corrugated aspect between the surface layer 41 and body 40. Another alternative, not illustrated, is to use a pre-corrugated interlayer, in which case only one of the facing surfaces may be grooved.

In a further alternative using explosive bonding, the corrugation of the facing surfaces is produced as part of the interface reaction. Such bonding can be carried out with or without an interlayer.

Claims

1. A method of manufacturing an article comprising the steps of creating a composite component having a surface layer (11; 21) of material different from the body (10; 20) of the component by bonding said surface layer to said body, and parting said component at a plurality of locations (12) to provide sections (24), characterised in that the article is a turbomachinery blade and the composite component has a plane surface layer, said parting taking place such that the sections (24) extend perpendicular to said plane, and in that each parted section is subsequently attached to a blade stem (30) by welding only the body portion (20) of said section (21) to said blade stem (30) to form said blade.

2. A method as claimed in Claim 1 characterised in that said section (24) is machined or ground to its finish form (31) and subsequently attached to said blade stem (30).

3. A method as claimed in Claim 1 or 2 characterised in that the component section has a body portion of titanium alloy, said body being subsequently attached to a blade stem (30) of titanium alloy.

4. A method as claimed in Claim 3 characterised in that the component section is attached to a titanium alloy stem (30) in its fully heat treated condition.

5. A method as claimed in Claim 1 or 2 characterised in that the surface layer (11; 21) is bonded to the body (10; 20) of the component by explosive bonding.

6. A method as claimed in Claim 1 or 2 characterised in that there is an interlayer (42) present between the surface layer (41) and the body (42) of the component, such interlayer being such as to tend to resist the diffusion of intermetallics from the surface layer of material into the body of the component.

7. A method as claimed in Claim 6 characterised in that at least one facing surface of the surface layer (41) or the body (43) is grooved (43, 44) prior to bonding in such a manner that the grooves on one surface are adapted to substantially intermesh with the grooves on the opposite surface, the interlayer (42) adopting a corrugated configuration in the bonded composite.

8. A method as claimed in Claim 1 or 2 characterised in that the body of the composite is a titanium alloy and the surface layer of material is selected from a group comprising one of the following metals or metal alloys; nickel, chromium, cobalt, copper, iron, hafnium, molybdenum, niobium, tantalum or titanium.

9. A method as claimed in Claim 6 characterised in that the body of the composite is made of a titanium alloy and the interlayer is selected from a group comprising the following materials or a compound of one of these materials with other elements; hafnium, molybdenum, niobium or tantalum.

Patentansprüche

1. Verfahren zur Herstellung eines Gegenstandes das folgende Schritte aufweist:
Schaffen eines Verbundbauteils, das eine Oberflächenschicht (11; 21) aus einem Material hat, das sich vom Körper (10; 20) des Bauteils unterscheidet, indem die Oberflächenschicht mit dem Körper verbunden wird;
dem Teilen des Bauteils an einer Vielzahl von Stellen (12), um Abschnitte (24) zu schaffen, **dadurch gekennzeichnet, daß** der Gegenstand eine Turbomaschinenschaufel ist und das Verbundbauteil eine plane Oberflächenschicht hat, daß das Teilen so stattfindet, daß sich die Abschnitte (24) senkrecht zu der Fläche erstrecken, und daß jeder eingeteilte Abschnitt nachfolgend durch Verschweißen nur des Körpers (20) des Abschnitts (21) mit dem Schaufelstiel (30) an dem Schaufelstiel (30) befestigt wird, um die Schaufel zu formen.

2. Verfahren gemäß Anspruch 1, **dadurchgekennzeichnet, daß** der Abschnitt (24) zu seiner endgültigen Gestalt (31) spanend bearbeitet oder geschliffen wird und nachfolgend an dem Schaufelstiel (30) befestigt wird.

3. Verfahren gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** der Bauteilabschnitt einen Körperabschnitt aus einer Titanlegierung hat und der Körper nachfolgend an einem Schaufelstiel (30) aus einer Titanlegierung befestigt wird.

4. Verfahren gemäß Anspruch 3, **dadurch gekennzeichnet, daß** der Bauteilabschnitt an einem Stiel (30) aus einer Titanlegierung in seinem vollständig vergüteten Zustand befestigt wird.

5. Verfahren gemäß den Ansprüchen 1 oder 2, **dadurch gekennzeichnet, daß** die Flächenschicht (11; 21) mit dem Körper (10; 20) des Bauteils durch Explosionsbonden verbunden wird.

6. Verfahren gemäß den Ansprüchen 1 oder 2, **dadurch gekennzeichnet, daß** es eine Zwischenschicht (42) gibt, die sich zwischen der Flächenschicht (41) und dem Körper (42) des Bauteils befindet, wobei eine solche Zwischenschicht dazu neigt, der Diffusion von Intermetallen aus der Flächenschicht des Materials in den Körper des Bauteils zu widerstehen.

7. Verfahren gemäß Anspruch 6, **dadurch gekennzeichnet, daß** wenigstens eine der sich gegenüberliegenden Flächen der Flächenschicht (41) oder des Körpers (43) vor dem Verbinden in einer solchen Weise mit Furchen versehen (43, 44) wird, daß die Furchen auf einer Fläche dazu angepaßt sind, im wesentlichen mit den Furchen auf der gegenüberliegenden Fläche in Eingriff zu sein, wobei die Zwischenschicht (42) eine gewellte Lage in dem verbundenen Verbund annimmt.

8. Verfahren gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** der Körper des Verbundes eine Titanlegierung ist und die Flächenschicht des Materials aus einer Gruppe ausge-

wählt wird, die eine der folgenden Metalle oder Metallegierungen aufweist; Nickel, Chrom, Kobalt, Kupfer, Eisen, Hafnium, Molybdän, Niob, Tantal, oder Titan.

9. Verfahren gemäß Anspruch 6, **dadurch gekennzeichnet, daß** der Körper des Verbundes aus einer Titanlegierung besteht und die Zwischenschicht aus einer Gruppe ausgewählt wird, die folgende Materialien oder eine Verbindung aus einem dieser Materialien mit anderen Elementen aufweist; Hafnium, Molybdän, Niob oder Tantal.

Revendications

1. Procédé de fabrication d'un article, comprenant les étapes qui consistent à créer une pièce composite ayant une couche superficielle (11 ; 21) en une matière différente de celle du corps (10 ; 20) de la pièce en liant ladite couche superficielle audit corps, et à diviser ladite pièce en plusieurs emplacements (12) pour produire des sections (24), caractérisé en ce que l'article est une aube de turbomachine et la pièce composite comporte une couche superficielle plane, ladite division ayant lieu de manière que les sections (24) s'étendent perpendiculairement audit plan, et en ce que chaque section divisée est ensuite fixée à une tige (30) d'aube en soudant uniquement la partie de corps (20) de ladite section (21) à ladite tige (30) d'aube pour former ladite aube.

2. Procédé selon la revendication 1, caractérisé en ce que ladite section (24) est usinée ou meulée à sa forme finie (31) et ensuite fixée à ladite tige d'aube (30).

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que la section de pièce comporte une partie de corps en alliage de titane, ledit corps étant ensuite fixé à une tige (30) d'aube en alliage de titane.

4. Procédé selon la revendication 3, caractérisé en ce que la section de pièce est fixée à une tige (30) en alliage de titane dans son état entièrement traité par voie thermique.

5. Procédé selon la revendication 1 ou 2, caractérisé en ce que la couche superficielle (11 ; 21) est liée au corps (10 ; 20) de la pièce par liaison par explosion.

6. Procédé selon la revendication 1 ou 2, caractérisé en ce qu'il y a une couche intermédiaire (42) présente entre la couche superficielle (41) et le corps (40) de la pièce, cette couche intermédiaire étant telle qu'elle tend à résister à la diffusion de composés intermétalliques depuis la matière de la couche superficielle dans le corps de la pièce.

7. Procédé selon la revendication 6, caractérisé en ce qu'au moins l'une des surfaces en vis-à-vis de la couche superficielle (41) et du corps (40) est rainurée (43, 44) avant la liaison de manière que les rainures sur une surface soient adaptées à s'imbriquer sensiblement avec les rainures sur la surface opposée, la couche intermédiaire (42) adoptant une configuration ondulée dans la pièce composite liée.

8. Procédé selon la revendication 1 ou 2, caractérisé en ce que le corps de la pièce composite est un alliage de titane et la matière de la couche superficielle est choisie dans un groupe comprenant l'un des métaux ou alliages métalliques suivants : nickel, chrome, cobalt, cuivre, fer, hafnium, molybdène, niobium, tantale ou titane.

9. Procédé selon la revendication 6, caractérisé en ce que le corps de la pièce composite est formé d'un alliage de titane et la couche intermédiaire est choisie dans un groupe comprenant les matières suivantes ou un composé de l'une de ces matières avec d'autres éléments : hafnium, molybdène, niobium ou tantale.

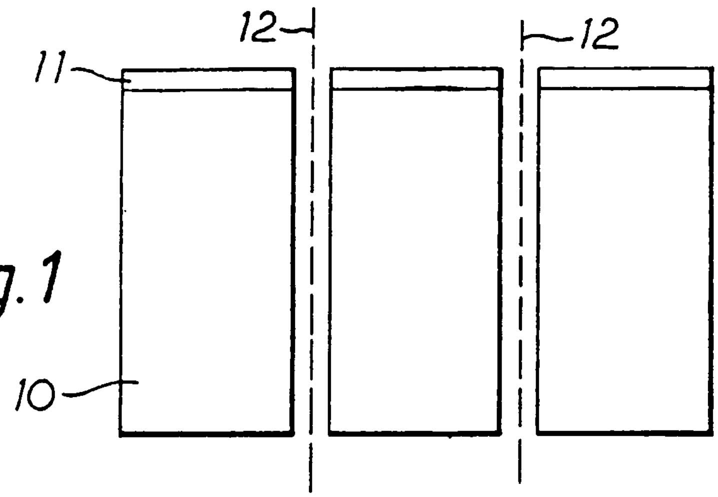

Fig.1

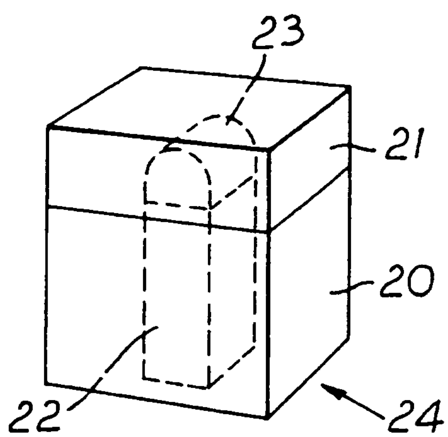

Fig. 2

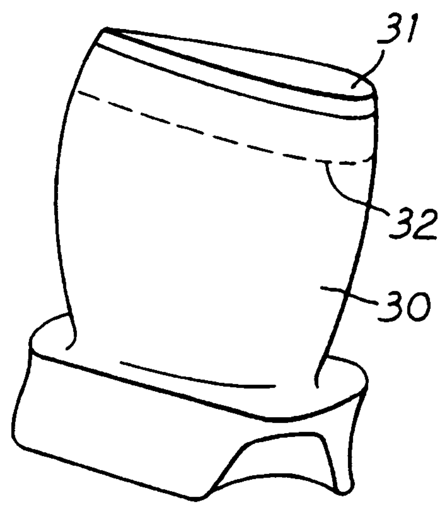

Fig. 3

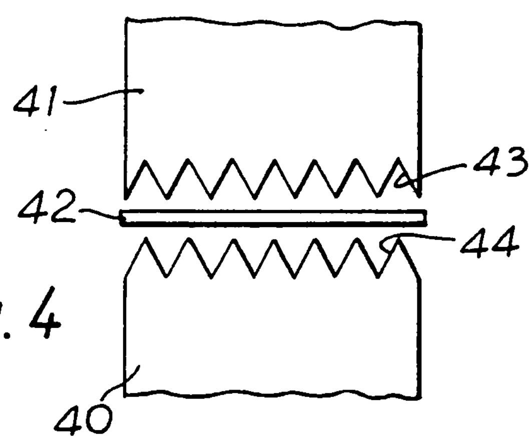

Fig. 4